Urban planning in vernacular governance in Iranian historic cities and its transformation in contemporary urbanization

Case study: Yazd

Seyyedeh Mojgan Sadat Akhavani

M.A in interior Architecture at Pars university of Architecture and Art

mojgan.akhavani@gmail.com

Abstract

In recent decades, special attention has been devoted to eco-friendly design and climate issues by urban designers and planners. In the past, Iranian urban planning was influenced by the climate and nature around it, which brought comfort and tranquility to the citizens. However, the unbalanced growing trend and even low quality of construction in all areas have caused the disappearance of this feature of Iranian urban planning. In the meantime, the city of Yazd is one of the oldest cities in Iran and one of the best examples of desert cities, where, since the beginning, natural factors, especially the hot and dry climatic conditions of the region, have been among the most influential factors in the formation of its physical body and development. Unfortunately, however, the changes that took place during the applying of changes in historic cities such as Yazd have changed the form of the new urban context. Accordingly, in the present study, it has been attempted to provide solutions for the new context of Yazd to create thermal convenience for citizens through exploring the body of the historical context of Yazd and how the former urban planners dealt with the hot and dry climate in urban design.

Keywords: Climate, Iranian urban planning, Historical context, physical forms
**Introduction**

Our traditional urban planning and architecture have been influenced by climatic design. Since the distant past, in Iran, various factors, the most important of which is climate, have played a role in determining the situation of the city and the way the body of the city is formed. Climate has been one of the most important factors in this regard. Assuredly, the sunshine and the wind have been the most important climatic elements, respectively. The intensity and direction of the wind have played an important role in the formation of cities. (Ghobadian 2011). Severe climatic conditions in cities are among the limiting factors for human behaviors and presence in the urban space. Therefore, the urban design attempts to make urban spaces suitable for human presence in a wide range of times by bringing sub-climates closer to the comfort zone. (Montazeri, Jahanshahloo, Majidi 2011). Perhaps it can be said that the climate is one of the most important factors influencing the design of cities in a way that its effect can be noticed in the warp and weft of urban context and even every single building and architectural elements of spaces.

In Iran, the architecture of buildings and cities in a hot and dry climate is one of the most obvious manifestations of the impact of climate on the formation of the body of cities and buildings. The most impressive and artistic Iranian designs can be seen in most areas of this climate. (Gorji Mahlabani, Musapour Moghadam 2011). The physical structure of a city can be influenced by many factors including climatic factors (Montazeri, Jahanshahloo 2011). All factors related to climate design in Iranian cities have played a role in shaping the body of the Iranian cities. This includes the outcome of wind on the general orientation of the city and how to make positive use of desert winds for climatic comfort, the effect of dust on the formation of the context and the placement of buildings next to each other, the effect of sunlight in different seasons on the building plan, and the effect of native soil and clay materials on temperature comfort (Gorji Mahlabani, Pourmoghaddam 2011). Given that one of the most critical parts of urban space design is considering to improve the quality of the environment and increase user satisfaction, it is essential to recognize the Climatic-environmental variables affecting thermal comfort and provide appropriate solutions to increase the quality of the urban environment.

The physical structure of Yazd city has been formed during historical periods following climatic features. Natural factors particularly climatic conditions have been one of the most influential factors in the growth and development of Yazd. (Montazeri, Jahanshahloo 2011). The purpose of any historical study is its informative past, the recognition of which is very fundamental. (Abdolhoseini 2011). Therefore, considering the rich structure and the design appropriate to the past climate of Yazd and spatial- physical disorderliness of this city’s body at present, and lack of attention to climatic issues in the design of Yazd, a question arises: how to offer solutions for designing the contemporary urban context in this city to provide thermal comfort for people by modeling the design of the historical context of Yazd and the impact of climate on the formation of the city’s body.

**Research objectives**

The present research mainly aims to achieve solutions for urban design in Yazd’s Newly-built urban fabric through employing climatic design used in historical fabric to ensure urban thermal comfort for the residents.

Secondary objectives
- examining the role of climate in the formation of Yazd historical urban fabric
- study of Yazd’s warm and dry climate
- identification of climatic factors contributing significantly to the formation of Iranian cities’ physical structure and thermal comfort of urban spaces
- proposing solutions to achieve an urban design in conformity with the warm and dry climate in Yazd’s newly-built urban fabric to ensure urban thermal comfort for the residents

**Hypothesis**
In this regard, considering the historical importance of Yazd, research hypotheses have been formulated as follows:

- It seems that the lack of attention to traditional Iranian urban planning in the new context of Yazd is the most important factor of climatic inefficiency in the physical space of the city.
- It seems that climate has a significant role in the formation of the physical structure of the historical context of Yazd.
- It seems that the study of the formation of the physical structure of the old texture of Yazd in harmony with the climate, will help urban designers in providing thermal comfort to residents of the new texture of the city.

**Research methodology**
The contextual structure of the present research is qualitative. The methods employed in the research include field surveys such as photographing and analysis of maps and photographs of the case study aiming to compare the formation of Yazd’s historical and new physical urban fabric in the face of a warm and dry climate. Also, the analysis and study of the physical characteristics of the Iranian cities in adaptation to climate have been conducted through desk research.

**Definition of climate**
The physical condition of the atmosphere which is among the characteristics of a certain geographical location is referred to as its climate. The climate of a specific place consists of a collection of atmosphere factors that have a relatively long prominence and characterize its weather for relatively long periods, these factors include temperature, rainfall, humidity, wind. And air pressure (Seyyedsadr, 2001).

Climate is derived from the Greek word “Klima” meaning leaning or tendency and consists of the general expressions of the atmosphere and air processes of a place or region over a relatively long period. Climate is a large system which, in turn, is made up of interactions among other systems including the atmosphere, hydrosphere, ice, and biosphere, and is a change occurs in any of the aforementioned systems, other systems find ways to adjust themselves to it gradually or quickly (Zolfaqari, 2010).

Given the concept of climate, scientists have classified the climates of various parts of the world based on specific indicators and interactions such as the extent of vaporization, relative humidity, and precipitation, sunlight, temperature, etc. Iran encompasses four main climates due to its special geographic properties, and a large part of its area falls into the category of “warm and dry” climate. This climate covers large parts of the central plateau of Iran where there is no rainfall for at least six months a year. The summers in this climate are extremely hot and dry, while the winters are exceptionally hard and cold. In these regions, the sky is clear during most of the months, there is no humidity in the air, and the temperature variation is quite high. The intensity of sunlight is extremely high in the summer, creating a peak temperature of 50-70 °C during the day and 15-25 °C at night (soflae, 2007). Considering the extremely dry climate in this climatic zone of the country (specifically Yazd), the daily temperature fluctuation is quite high which effectively impacts human thermal comfort (Nadi, Malek Hosseini, 2014).

Hence, the investigation of urban structure in conformity with the warm and dry climate is of significant importance to ensure the thermal comfort of the residents of cities such as Yazd.

**The concept of urban physical space**
The physical structure is among the prevalent key concepts in urban planning and design since it engages all structural elements and components of the city and determines how these elements function and are located across the city. Numerous components are involved in generating space, including economic, social, and environmental components which aggregate to constitute urban morphology (Wiedman et al, 2012).
Urban space has been defined through various concepts in the field of different specialties involving the city, each placing different stress on each of the social, physical, or functional dimensions of this space. Certainly, no definition of urban space can separate these human life dimensions from one another and offer an independent definition of urban space (Pourahmad et al, 2015).

In his definition of urban space, Rob Krier confines all perceptional vales of urban space to the object itself—which is the physical area outside of the buildings-, but adds "every examination tends to be based on personal preferences". Therefore, different sensory habits of people at various times and spaces might lead them to form different perceptions of the realities in the urban space based on their distinct values (Pourah-md, 2015).

To understand the concept of physical urban space, one needs to develop the concept of the physical body of the city in its specific semantic domain. In urban design literature, the word “physical body” is the equivalent of the shape or form of the city. In his book entitled “image of the city”, Kevin lynch defines the form of the city as the physical and visible representations of the city (Lynch, 2005). In his other book “Good Urban Form”, lynch offers a further definition of this concept: the form of a biological complex often referred to as the physical environment generally consists of the spatial pattern of large, permanent, and immobile physical elements in the city such as buildings, streets, utilities, hills, rivers, and maybe also trees (Lynch, 2007). Some also consider the physical body of the city as a container for urban activities and their potential occurrence, or in other words, a container for human and all his activities in the city (Pourahmad, 2015).

**Physical elements of the city**

**Skyline**: the common denominator between the sky and urban buildings and natural volumes that facilitates judgment about the pleasantness and unpleasantness of the body of the city (Pourahamd et al, 2016).

**Urban profile**: urban profile is determined by how the city appears as a surface to the observer while the sun is setting behind the body of the city (Pourahamd et al, 2016).

**the edges**: gaps or boundaries existing between two adjacent parts of the city such as the difference between two different structures' heights, high walls along the streets, or similar rows of buildings on the side of streets (Majedi, 2010).

**Mass and space volumes**: spaces filled with manmade or natural masses in contrast to empty spaces within the urban boundaries whose frequency or number impacts the form and density of the body of the city (Pourahmad et al, 2015).

**Urban symbols and landmarks**: urban spaces are usually distinguished through symbols and landmarks making them different from other human settlements in a general or specific way, making every city distinct, and contributing to cities’ identity formation and conceptual and communicational elements. There are cases where landmarks turn into symbols such as in the case of Eiffel tower and Azadi tower which were originally landmarks but have become symbols over time. (Poorahmado et al., 2015).

**Urban passages and nodes**: passages are urban components through which potential or actual movement takes place and consists of sidewalks, roads, underground passages, trams, or railways (Mozayyeni, 2004). Urban nodes include the intersection between roads and streets, squares, or places with dense buildings encouraging social gatherings and activities (Majedi, 2006).

**Urban facades**: façade designs are addressed in the study of urban volumes in the physical body of the city in terms of scale and proportions, style, construction, building structures, materials, color, and exquisiteness which significantly plays a significant part in their visual effectiveness. Innovation and creativity in urban facades can provide the city with a desirable view (Adibi Saadinejad, 2011).

**Thermal comfort**

The dialectic approach believes that human both affects and is affected by its environment, which is referred to as the organismic approach in anthropology. Undesirable climate conditions are among the dimension that human has tried hard to attenuate through this approach. It can easily be argued that human interventions in nature—and in other words, a majority of world history’s urban planning and
architecture works -, demonstrates attempts at improving thermal comfort. Thermal comfort has gained the attention of many scholars over the past decades which might be due to the comprehensive climate dialogues (Montazeri & Jahanshahlu, 2017). The considerable growth of literature in this area and the urban planners’ ignorance towards climatic issues in designing contemporary urban fabric make it necessary to address climate in urban planning aiming to improve the thermal comfort of city dwellers.

**Climatic conditions and urban form**

Since Iranian architecture and urban planning are compatible with both people and the environment (Nazer, 2013), all urban fabrics, building forms, and building materials in all parts of Iran and the world are significantly influenced by climate (Sartipipour, 2009). This conformity can be clearly observed in factors affecting an area’s climatic conditions such as the angle of radiation, latitude (i.e. the distance from the equator), the intensity and direction of seasonal winds, water and moisture available in the region, and finally, altitude and topographies (Seraji, Kermani, and Farkhani, 2013). It can be confidently said that urban design in conformity with the rough weather condition of warm and dry climate is among the significant achievements in adapting and providing a desirable living environment.

Every manmade element changes the weather around it. The geometry and cross-section of a city, its size and dimensions, its density and compactness in vast scales, the shape, height, and size of the buildings, the orientation of the streets, buildings, and open spaces, and land coverings are all factors impacting the climatic transformation of the cities. Higher attention to the role of the physical body of cities in open spaces’ microclimate can be observed in the research literature of recent decades (Motazeri & Jahanshahlu, 2017).

According to previous research, researchers have come to the conclusion that the best orientation for cooling down the temperature is implementing north-south rectangular yards that keep the direct sunlight in the center of the yard for a very short while; this finding is also generalizable in other climates with less sunlight (Berkovic & Yezioro). The ENVI-mat microclimate was used to simulate the outdoor thermal comfort in Algeria’s warm and dry climate and examined the impact of different orientations in urban corridors, concluding that thermal comfort gradually improves with the increase of buildings’ height to street width ratio (Johansson, 2006). Assessments conducted in Morocco and Fez also indicated that compact urban design with deep urban corridors is favorable for summer (Boucheriba & Bourbia, 2010; Montazeri & Jahanshahlu, 2017).

**Enclosure (height to width ration)**

Results indicate that the extent of passages’ enclosure plays a part in changing the climatic condition and temperature in the proximity of buildings and passages. The significance of this ration is that it determines the amount of radiation received by the floor surface in urban spaces and changes the temperature of these surfaces, impacting ventilation, and how the wind blows as well. Passages’ enclosure is among the influential parameters contributing to urban thermal comfort in cities with a warm and dry climate such as Yazd. Higher enclosure results in more shading in the passages and, therefore, is among the measures taken in historical urban fabrics to adjust urban spaces for the presence of pedestrians (Montazeri & Jahanshahlu, 2017).

**The sky view factor**

The sky view factor is another factor playing a significant part in the changes in heat in urban streets. This factor I conventionally measured as a number between zero and one, and is determined through analytical calculations or photographing methods using special cameras. If the factor equals one, it means that the sky is fully visible from the ground level, and is the factor equals zero, it means no part of the sky can be seen from the ground level. The higher the value of this factor is, the faster the urban street will cool down; and the lower this factor is, the longer the street will remain hot during the day and transmit heat during the night. The Use of Sabats with a zero sky view factor is another measure
taken in Yazd historical urban fabrics aiming to moderate the challenging climatic conditions of the warm and dry climate (Montazeri & Jahanshahlu, 2017).

**Street orientation**

The daytime temperature in urban streets is associated with their orientation towards the sun since the duration of receiving solar radiation determines the temperature. The orientation of the streets can also improve urban ventilation potentials considering the direction of the wind. In fact, determining passage orientation in urban space in conformity with climatic conditions can contribute to the control and reduction of thermal pollution, dust movement, etc. Since the body of the transportation network is shaped by the arrangement of the parcels (masses) in the blocks, the streets are figured according to the shape of the blocks; therefore, this component is associated with "block orientation" and "the pattern of blocks placement", and passage orientation is dependent on the orientation of parcels and blocks. The way this indicator affects thermal comfort is by influencing heat and wind penetration into the passages by changing their orientation (Montazeri & Jahanshahlu, 2017).

<table>
<thead>
<tr>
<th>Scholar</th>
<th>Physical components of urban form</th>
<th>Thermal comfort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bosselmannet al. (1995)</td>
<td>Dimensions of the streets and location of the buildings</td>
<td>Radiation, wind, and thermal comfort</td>
</tr>
<tr>
<td>Toudert et al. (2006)</td>
<td>Orientation, the ratio of urban corridors, streets’ height to width ratio</td>
<td>Outdoor thermal comfort</td>
</tr>
<tr>
<td>Bourbia et al. (2010)</td>
<td>Geometric properties of the streets: height to width ratio, Sky Vie Factor (SVF), orientation (defined by its longitudinal axis)</td>
<td>Street weather (street temperature)</td>
</tr>
<tr>
<td>Dalman &amp; Salleh (2011)</td>
<td>Street orientation, street W/H ration</td>
<td>Thermal comfort (comfort temperature)</td>
</tr>
<tr>
<td>Kruger et al. (2011)</td>
<td>Urban geometry: street axes, buildings’ height, and other properties</td>
<td>Outdoor thermal comfort, air quality (pollution dispersion)</td>
</tr>
<tr>
<td>Noori Kakon (2012)</td>
<td>Street form: form and height, buildings’ form</td>
<td>Outdoor thermal comfort</td>
</tr>
<tr>
<td>Yang et al. (2013)</td>
<td>Urban form and density</td>
<td>Outdoor ventilation potential</td>
</tr>
<tr>
<td>Paramita, Hiroatsu (2013)</td>
<td>orientation, street W/H ration</td>
<td>Average radiation temperature (air temperature)</td>
</tr>
<tr>
<td>Middel et al. (2014)</td>
<td>Landscaping, building alignment</td>
<td>Temperature, wind direction</td>
</tr>
<tr>
<td>Sanaieian et al. (2014)</td>
<td>Urban block forms</td>
<td>Thermal performance, solar radiation, and ventilation</td>
</tr>
<tr>
<td>Taleghani et al. (2015)</td>
<td>Forms including a yard</td>
<td>Outdoor thermal comfort in urban spaces, duration of direct radiation, the average temperature of the radiation</td>
</tr>
<tr>
<td>Mahmoodi et al. (2010)</td>
<td>Sky view factor, shadow, distance to the buildings</td>
<td>Thermal comfort</td>
</tr>
<tr>
<td>Ali-Akbari (2012)</td>
<td>Urban decline: buildings’ alignment form, building details, orientation, building plan form, height, physical and qualitative properties of the transportation network, size and density, accessibility, land use patterns, enclosure, connection, and integration</td>
<td>Microclimate and energy</td>
</tr>
<tr>
<td>Monshizadeh et al. (2013)</td>
<td>Buildings height</td>
<td>Thermal comfort</td>
</tr>
</tbody>
</table>

(Source: Montazeri & Jahanshahlu, 2017)
Physical properties of Iranian cities in conformity with the warm and dry climate

Fabric density
A dense and compact urban fabric can be observed in warm and dry parts of Iran, in which adjacent houses share a wall. Existence of shared walls in building construction results in the compactness of the neighborhood fabric and not only saves money in terms of construction costs but also provides improved protection against climatic elements and minimizes the surfaces exposed to sunlight. In this way, the solar radiation received by each housing unit is felt in the hot summer. The compact collection of adjacent houses makes for a high population density and organizes pedestrian trips. Higher compactness also results in the minimization of sky view factor and the area of surfaces exposed to sunlight, so that every housing unit can preserve the solar energy within itself for a longer time. Higher-density urban fabric can also prevent the penetration of strong storms and winds into the building. This is especially the case in regions where the unfavorable winds are more intense; in such cases, it has been observed that building density tends to be higher, yards tend to be smaller, and passages are formed organically (Moztarzadeh & Hojjati, 2015).

Proper orientation of buildings and housing units
Building orientation is considered as the most essential principle in the construction of cities with a warm and dry climate. Accessibility networks and passages are usually designed with a north-south orientation to prevent hot winds and strong storms, so the buildings are located in a slightly northeast-southwest direction. This direction or Ron is called "Raste Ron" (the straight Ron). The alignment of buildings conforming to this orientation will facilitate the maximum use of favorable winds and remaining protected from sunlight. The alignment of rooms around the yard in historical houses is in a way that summer rooms are always facing away from the sun which protects them from hot summer afternoons. In Yazd, winter rooms face south-west instead of directly facing south (Moztarzadeh & Hojjati, 2015).

Communicational ways for the city to adapt to its climate
The organic shape of passages in the urban fabric of historical neighborhoods in Iranian warm and dry regions brings about positive consequences for the pedestrians. These passages protect the pedestrians from direct unfavorable winds and storms which would otherwise bother them. Covering some passages is another characteristic of passages in Iranian warm and dry regions. These covered passages—which are called "Sabat"s- are among the achievements of Iranian architecture and urban planning and are influenced by the climate, structure, and social and cultural components of Iranian communities, examples of which can be found in Yazd (Moztarzadeh & Hojjati, 2015).

Climate-friendly materials
Building materials demonstrate different behaviors in every climatic condition, so the type of material used in a building plays a huge part in its dwellers' comfort in a warm and dry climate. In this type of climate, materials must be selected that has a high heat-resistance and heat capacity. Mud, clay, and bricks are among the materials that constructors use in this climate, and in cases where wood and stone are used, they are mixed with mud since it is adapted to the weather of this particular climate (Nurtaghani & Rahimi, 2016). Clay, which is produced with the least transformation in the environment and has the highest compatibility with it, is also the most economically-convenient material (Moztarzadeh & Hojjati, 2015). Having a low heat transfer rate, clay is a good insulator for the building. Also, it has a limited radiation absorption and a high reflection scattering due to its rough texture and having the same color as the environment.

Buildings in the environment of Iranian cities
Certain construction methods have been used in the construction of service and residential buildings in warm and dry areas to improve the dwellers’ comfort. Most traditional houses in Iranian warm and dry areas incorporate a high building which increases the shadowed surface in summer and ultimately results in a relative coolness of movement corridors in addition to having security benefits (Moztarzadeh & Hojjati, 2015).

Short entrance doors for housing units used to be installed on these high walls, the reason for the doors’ shortness was mainly associated with preventing severe sunlight and the entrance of dust induced by unfavorable winds (Dehghan Manshadi, 2006). Some other buildings in Iranian regions with a warm and dry climate have roofs shaped like a dome. These mud and clay domes have a more effective performance in reducing solar heat compared to flat roofs. The dome shape of the roof increases the roof's surface area and, therefore, divides the severity of solar radiation by a larger surface (Kheirabadi, 2007).

**Presence of courtyards in the buildings**

A courtyard refers to an open space placed in the center, side, or proximity of the building and has no canopy. Buildings with courtyards—especially residential ones—in warm and dry regions in Iran are completely introverted and have very few interactions with the outside environment. The benefit of having a courtyard in the building is a definite and easy improvement of thermal comfort, especially in warm and dry regions (Moztarzadeh & Hojjati, 2015). Like a natural oasis, a central courtyard brings together water, light, wind, and plants, providing the dwellers with a comfort zone in the midst of an unfavorable environment (Ahmadi, 2005). Flowers, plants, and trees also play a significant part in cleansing the incoming air and purify it before it enters the interior spaces (Kock Nilsen, 2010).

**Colors**

The color of the roof and walls of the building have the most essential role in the absorption of solar radiation in regions of Iran with a warm and dry climate where the intensity of solar radiation is higher than in other regions. Color is considered to be a very important and controlling factor in different orientations of the building and direction of solar radiations shining in walls and, especially, the roof which has the highest absorption of solar energy. The impact of bright colors of exterior surfaces is quite high on decreasing the daily temperature of the building—which is due to the reflected sunlight, the most important and largest source of heat—, increasing heat capacity, and ultimately providing comfort at night time (Moztarzadeh & Hojjati, 2015).

**Wind towers**

Construction of wind towers has been another method used in the construction of buildings in warm and dry climates, which plays a significant role in providing a desirable environment in the summer through natural ventilation. A wind tower traps dominant summer winds and guides them into the hall, pool house, basement, and pool house through canals. The wind tower might be open in all directions, or a specific dimension in case there is a dominant wind (Moztarzadeh & Hojjati, 2015).

<table>
<thead>
<tr>
<th>Physical body</th>
<th>Urban physical characteristic</th>
<th>Explanation</th>
</tr>
</thead>
</table>
| 1 Urban fabric | High density and compactness of the fabric | -presence of shared walls  
- high population density  
- casting shadows in passages and buildings  
- preventing the penetration of intense winds and storms |
| 2 orientation | Proper orientation of the buildings | -north-south orientation of buildings to prevent intense winds and storms  
The northeast-southwest orientation of the buildings  
- maximum use of favorable winds  
- remaining safe from intense sunlight |
| 3 Communication | Responsive | -the organic shape of the passages and protection from |
Case study

Yazd

Yazd is considered one of the historical Iranian countries and among the best cases of Iranian desert cities. The name of this city reminds one of the authentic and artistic works of art. "Fahadan" is one of the most historical neighborhoods of Yazd, placed between Bazar-e-No, Shah Abolghasem, and Kushk-e-No neighborhoods. This neighborhood is confined to Bazar-e-No and Vaqt Alsae neighborhoods from the south, Shah Abloghasem and Kushk-e-No neighborhoods from the east, and Imam Khomeini St. from the south. Fahadan neighborhood was established in the early fifth century AH. Among the distinct elements of this neighborhood, one could point out the shrine of the sheikh of Fahadan, Ghadamgah mosque, and Ziaie school of Alexander prison.

![The urban fabric of Yazd, Iran (the author, adapted from google earth)](image)

Comparison of Yazd’s new and historical urban fabric structure in harmony with the regional climate
Yazd has benefited from social, economic, and environmental benefits due to following a pattern in conformity with the regional climate from long ago, but gradually abandoned this pattern along with the development and growth of the city. Given that Iranian urban planning has performed successfully in conformity to the climate in past, the present paper proceeds to analyze the physical properties of Yazd historical urban fabric in the face of the warm and dry climate and compare it with the new urban fabric, aiming to propose urban design solutions for the new urban fabric of Yazd based on the patterns discovered in historical Yazd, so that the dwellers’ thermal comfort can be provided in the best way.

First, we will proceed to examine the physical properties of the historical urban fabric of Fahadan, Nazarkardeh, Lab-e-Khandaq, and Chahar Menar neighborhoods in conformity with the climate and will then compare their physical properties to those of Yazd’s new urban fabric.

<table>
<thead>
<tr>
<th>Physical properties</th>
<th>explanation</th>
<th>Pictures from the historical fabric of Yazd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban fabric compactness</td>
<td>Compact fabric and presence of shared walls between the buildings</td>
<td></td>
</tr>
</tbody>
</table>
| **Organic passages** | - northeast-southwest orientation  
- Organic formation of passages to prevent the penetration of disturbing winds  
- Narrowness of passages to case shade |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Central courtyard</strong></td>
<td>Presence of central courtyards, introversion of the fabric, and presence of vegetation</td>
</tr>
</tbody>
</table>
| **Materials and colors** | - Use of local materials with low heat transfer rates  
- Bright color of the materials |
| **Domes** | Presence of domes on the roofs of historical buildings to reduce solar heat |
| **Sabats and wind towers** | - Wind towers capture the dominant wind and guide it into the building 
- Presence of sabats in the passages to cast shade |

Source: the author

As demonstrated, the historical urban fabric of Yazd has performed quite successfully in adapting itself to the conditions of warm and dry climate. However, the new constructions in Yazd lack the slightest resemblance to the physical structure of the historical urban fabric, the examples of which can be observed in Safaieh neighborhood and laleh residential area. The research will proceed to compare this newly-built fabric with the old fabric.
The new urban fabric of Safaieh and Hamidieh neighborhoods, Yazd (Author, adapted from Google Earth)

Table 4: comparison of new and historical urban fabrics of Yazd in conformity with the warm and dry climate

<table>
<thead>
<tr>
<th>Physical components</th>
<th>Explanations</th>
<th>The new urban fabric of Yazd</th>
<th>The historical fabric of Yazd</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organic</strong></td>
<td>Contrary to the historical fabric, the passages in new fabric are not formed organically. The passages of the new fabric are wider and cast smaller shades.</td>
<td><img src="image1" alt="New fabric" /></td>
<td><img src="image2" alt="Historical fabric" /></td>
</tr>
<tr>
<td><strong>Orientation</strong></td>
<td>The orientation of buildings and passages in the new fabric is completely opposite to that of the historical fabric, demonstrating a northwest-southeast orientation.</td>
<td><img src="image3" alt="New fabric" /></td>
<td><img src="image4" alt="Historical fabric" /></td>
</tr>
</tbody>
</table>
Conclusions and suggestions

The results of the present research indicate that following the essential principles of climatic design knowledge based on Iranian historical urban design creates an environment that improves thermal comfort in urban spaces. Also, indicators such as building height, occupation level and urban fabric density, the orientation of the passages, etc. are among the factors influencing climatic conditions and thermal comfort. Climate-aware urban planning results in guidance of the form through the identification of climatic parameters as the guiding structure, and when urban form is generated under the influence of wind, solar radiation, and other such parameters, it becomes able to provide its dwellers with climatic comfort –something that has been observed in Iranian cities, especially Yazd, in the past. Comparison of Yazd historical urban fabric in Fahadan neighborhood and its newly-built fabric in Safaieh neighborhood indicated that the urban planning of contemporary urban fabrics of Yazd does not follow the historical urban planning patterns and cannot perform successfully in providing thermal comfort for its residents. Therefore, to realize the Iranian urban planning patterns in conformity with the warm and dry climate, the following solutions are suggested for the design of Yazd’s contemporary urban fabric to ensure the residents’ thermal comfort through drawing inspiration from historical Iranian urban planning:
- creating a sense of enclosure in pedestrian passages of the urban fabric
- increasing enclosure in urban spaces through increasing building density in the urban fabric
- establishing vegetation in the city through the design of parks, etc.
- casting shade in the passages through the use of elements such as Sabats, an abundance of which can be found in historical Iranian urban planning
- developing passages with a northeast-southwest orientation
- refraining from designing wide passages to cast more shade

References:
[15] Seraji Kermani, Sanaz. 2013, what is Indigenous Architecture?, The eighth conference on urban planning and sustainable development with a focus on indigenous architecture to sustainable city, Khavaran Higher Education Institute, Mashhad